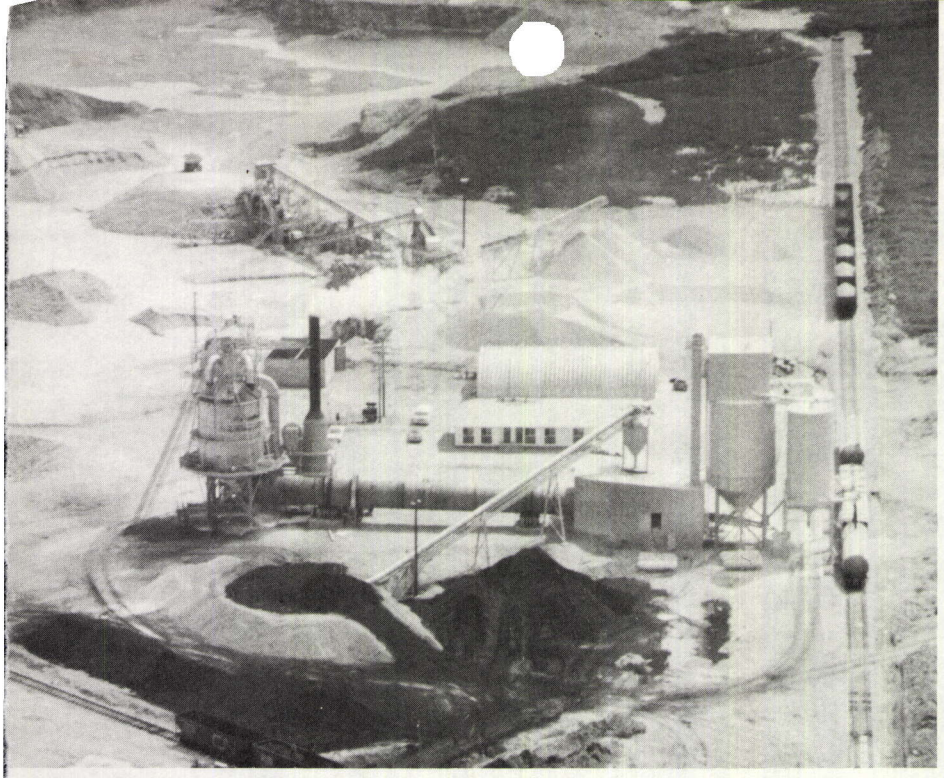


Faulkner: overall view of plant

LIME

produced in new Western plants

Rock Products Division
Steel Brothers Canada Limited

In early 1975, Steel Brothers Canada Ltd made the first shipments of chemical grade quicklime from their new 300 ton per day lime plant at Pavilion Lake, BC. This plant is unique in two ways: firstly, because both the plant and its supply of raw material are located entirely on Indian land; and secondly, because the calcining system in the plant incorporates the prototype of a heat recuperating device which was designed and pioneered at this location.

Background: In August 1972 the Federal Department of Indian Affairs contacted Steel Brothers to see if they would be interested in exploring and possibly developing a limestone deposit located on the Pavilion Indian Reserve #3, approximately 24 miles north and west of Cache Creek. The Department then put Steel Brothers in contact with the Pavilion band of Indians, and in due course an agreement for lease of land and extraction of limestone was concluded. Exploration of the limestone deposit, and design work for the plant were completed during 1973 with construction starting in November of that year. Initial firing of the plant was done in December 1974 with first product being shipped in early 1975.

Pavilion Lake:

The plant is located adjacent to and on the north side of Highway 12. High calcium limestone averaging 97.2% $CaCO_3$ is quarried from a massive spur that rises just behind the plant. There are presently two 25-foot benches being worked. The 3.5-inch diameter blast holes set on an 8-foot by 10-foot pattern are drilled with a Gardner-Denver Air-trac powered by a 900-ft³/min Ingersoll Rand compressor. Amex II with a toe charge of Powerfrac 75 is the blasting agent, and initiation is by detonating fuse down-lines.

Shot rock is loaded into tandem dump trucks and transported approximately ¼-mile to the crusher receiving hopper.

CRUSHING & SCREENING

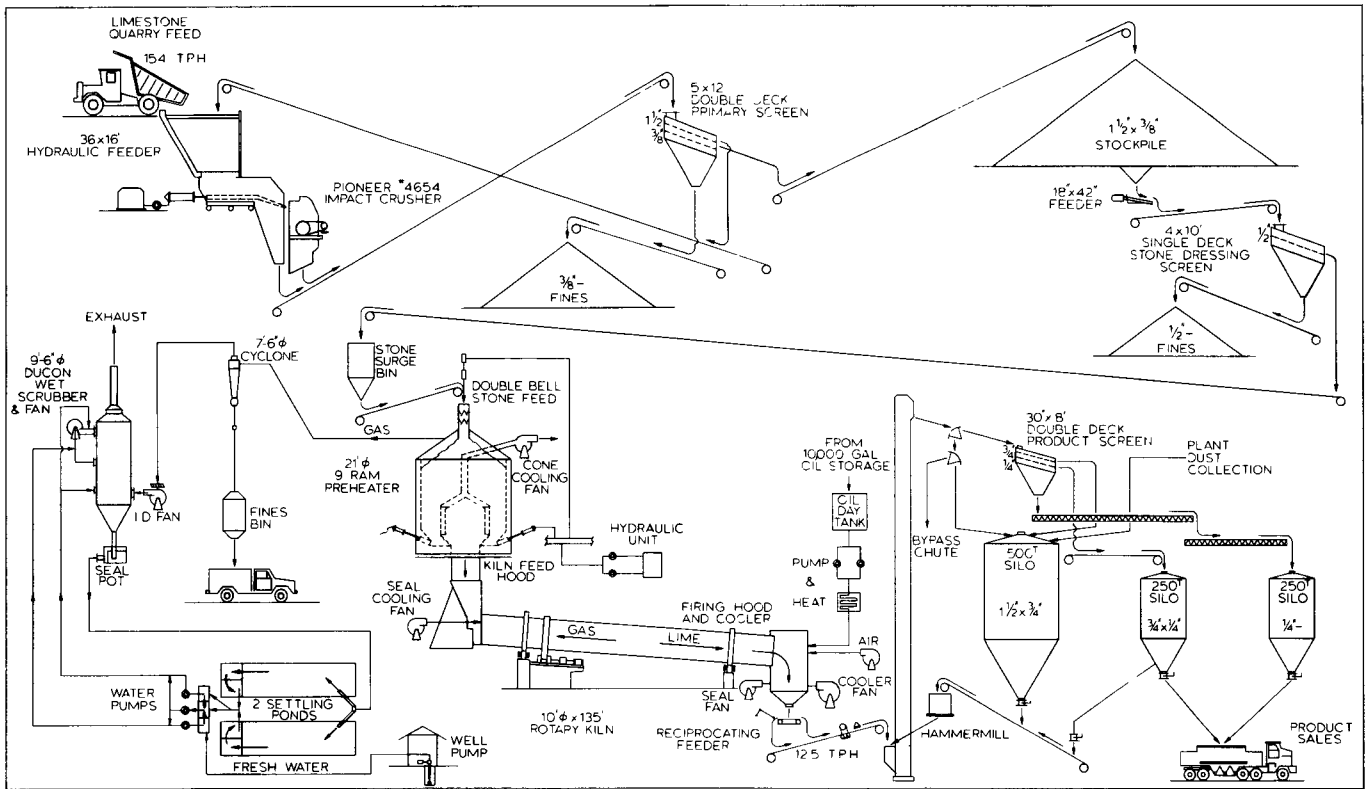
A 36-in by 16-foot Hydrastroke feeder equipped with a short grizzly section feeds the quarry-run limestone to a 4654 Pioneer single rotor impactor. The crusher discharges directly onto a conveyor which already has a cushion of 2-in minus stone that has been scalped out by the grizzly feeder. This cushion prevents belt damage from high velocity rocks which occasionally ricochet off the rotor or breaker bars of the impactor. Crushed material is then conveyed to a 5 x 12 Pioneer double deck screen, fitted with a 2-in top deck and ⅜-in bottom deck. Oversize from the top deck is conveyed back to the crusher; 2in x ⅜in is conveyed to a large conical stockpile to be recovered as kiln feed.

The minus ⅜in stone passing the lower deck is conveyed to a stockpile for possible future use as road material. The 2in x ⅜in kiln stone is recovered via a belt conveyor located in an 8-ft diameter tunnel beneath the stockpile. This conveyor discharges onto a 4-ft x 10-ft Tyler screen, located just outside the tunnel, which screens out any fines that may be generated in handling through the stockpile. The cleaned stone is then transferred via belt conveyor to a surge bin located above the stone preheater. The entire reclaim system is automatically controlled by level sensors in the surge bin.

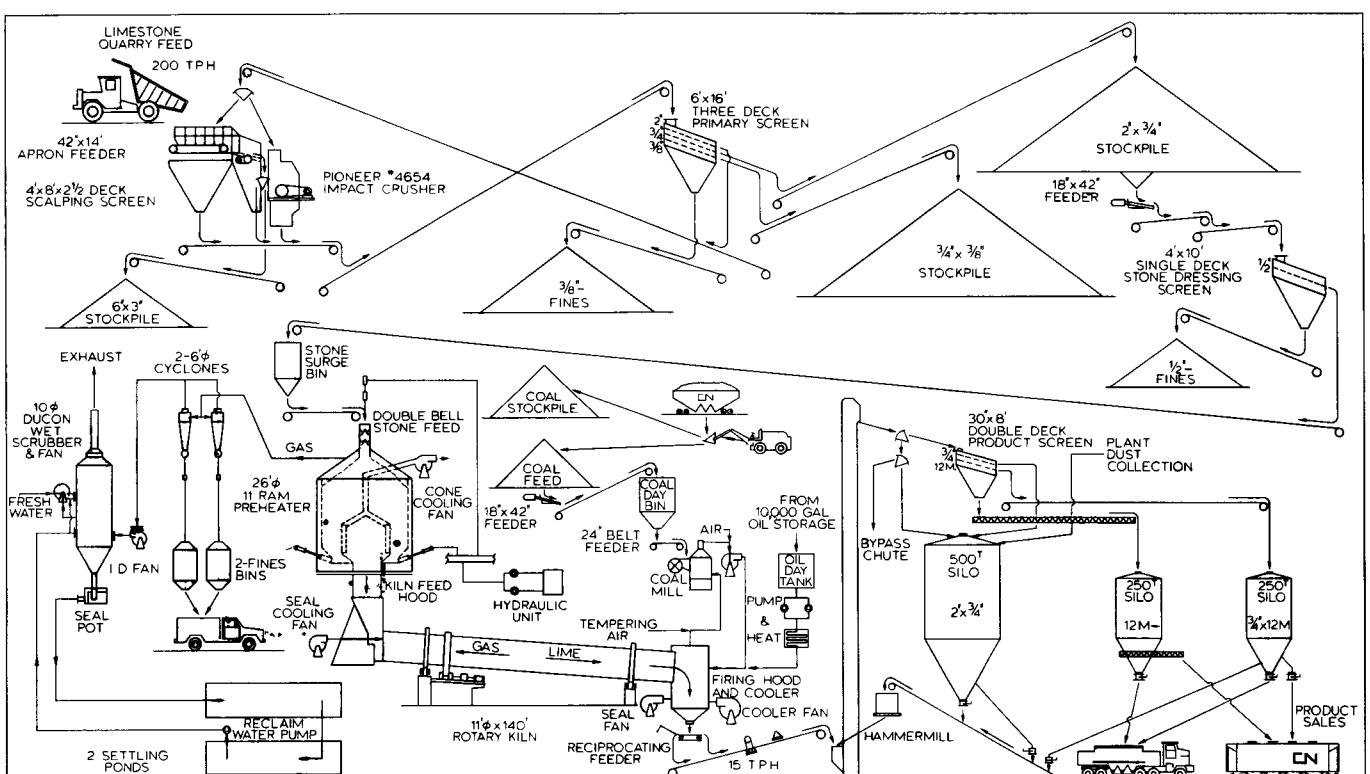
CALCINING PLANT

The 300-ton per day calcining system consists of a 10-ft x 135-ft rotary kiln equipped with a 21.5-ft diameter preheater that was pioneered at this plant as a result of the skyrocketting cost of fuel. The preheater is of modular design and consists of a number of vertical chimneys or segments located radially around a central vertical chimney. This unit consists of nine segments, but any number can be accommodated by increasing or decreasing the diameter of the outside shell and the inner chimney.

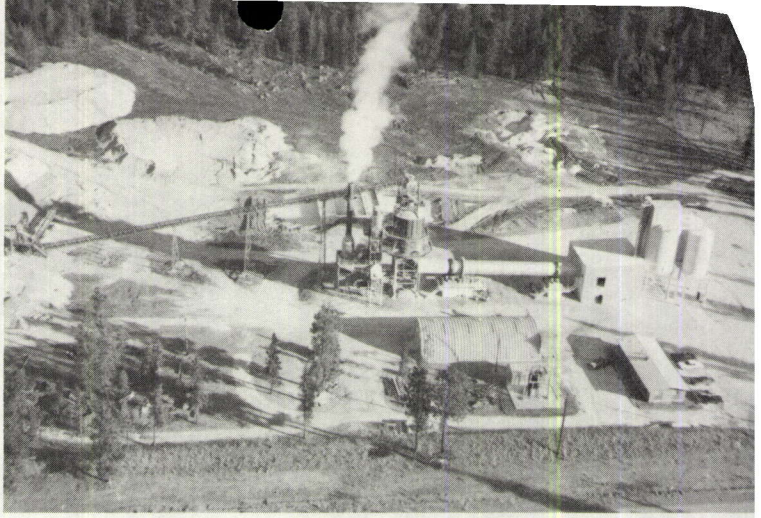
All internal surfaces of the preheater are constructed of refractory material. 1900°F exhaust gas from the rotary kiln is drawn into the central chimney of the preheater and distributed through ports



FLOW SHEET	STEEL BROTHERS CANADA LTD. PAVILION LAKE LIME PLANT, CACHE CREEK B.C.	WESTERN PROJECT MANAGEMENT LTD. DELTA, B.C. SEPTEMBER, 1976



FLOW SHEET	STEEL BROTHERS CANADA LTD. FAULKNER LIME PLANT, FAULKNER, MANITOBA	WESTERN PROJECT MANAGEMENT LTD. DELTA, B.C. SEPTEMBER, 1976



Pavilion Lake

Brothers have a bulk terminal located on CP Rail at Ashcroft, and therefore have the ability to transfer product into this by truck, to be loaded onto rail for shipment to more distant points.

ENVIRONMENTAL CONTROL

The dust that is frequently prevalent in crushing and screening operations of this type is suppressed by means of water sprays in the crushing chamber. The dynamic action of the rotor ensures complete wetting of all particles without using an excess of moisture.

Exhaust gas from the induced draft fan on the pre-heater is passed through a Ducon UW4 wet scrubber before being emitted to atmosphere. The collected dust is discharged from the bottom of the scrubber as a thin slurry, which is then flumed to a multi-compartment settling tank. Once the particulates have settled out in the tank(s), the water is recirculated to the scrubber. Collected sludge is removed from the tanks on a regular basis with a backhoe, and is disposed of in a landfill that is stabilized by the addition of crushed rock. Evaporation from the stack and the ponds is made up by the addition of fresh water at the scrubber.

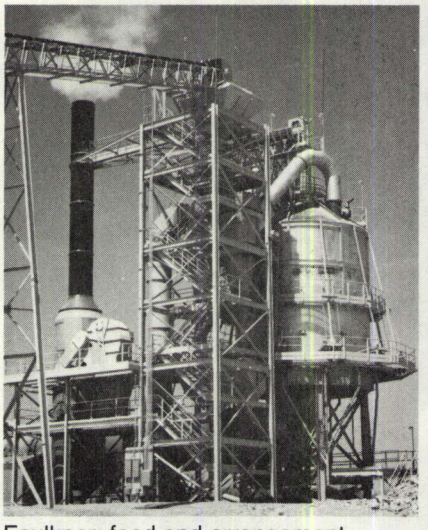
Nuisance dust generated in the main part of the plant is controlled by vacuum pipes at the sources such as conveyor transfer points, hammermill, and screen. The vacuum system exhausts through a small baghouse which returns the collected dust to one of the finished product bins.

Design and construction of the plant were coordinated by Western Project Management Ltd, of Delta, BC.

PEOPLE

During the negotiations relative to the leases for land and limestone, Chief Gary Harry and his Band Council placed great emphasis on employment opportunities for the Band. The plant employs 17 people, the majority being native Indians, and a recent survey done by the National Lime Association of Washington, DC, shows that the wages paid at this plant are the highest of any lime plant in North America. This, coupled with the fact that Indians who earn their living upon a reservation are not subjected to Income Tax, certainly supports Chief Harry's priorities.

Key personnel are: Division Manager, Don Harvey; Plant Manager, Jim Jordon: Sales, Glynn Morrey-Jones.



Faulkner: feed end arrangement

Faulkner: stone screening plant

2. NEW LIME PLANT FOR MANITOBA

On 1 August 1976, a 350-ton per day version of the Pavilion Lake Plant was brought on stream at Faulkner, Manitoba. Located 145 miles north of Winnipeg, this plant replaces the company's vertical kiln plant that has operated at the nearby town of Moosehorn for over 50 years.

Design work for this plant started in November 1974 with the first construction personnel moving on site in April 1975. Because the plant design is quite similar to the Pavilion Lake Plant, and the same Western Project Management design and construction teams were able to swing directly from one project to the other, the lead time between design and start-up was kept to an absolute minimum.

High-calcium limestone averaging 98% $CaCO_3$ is quarried from the extensive Elm Point (Devonian) Formation upon which the plant is located. The seam is horizontal and is worked in two 20-foot benches, using an Airtrac and a 2.5-yard front end loader. Two fifteen-

ton Euclids haul the shot rock the ¼-mile to the crusher receiving hopper.

CRUSHING AND SCREENING
A Pioneer 42-inch x 14-foot apron feeder feeds rock to a 4-ft x 8-ft Mesabi scalping screen which allows the minus 2-in stone to bypass the crusher. Plus 2-in is fed to the 4654 Pioneer impactor, whose product is conveyed to a 6 x 16 Ty-Rocket screen. Oversize is returned to the crusher, and three products (2-in x ¾-in; ¾-in x ⅜-in; and ⅜-in minus) are stockpiled by conveyor. The 2-in x ¾-in stone is recovered from stockpile and conveyed to a surge bin above the stone preheater.

CALCINING PLANT
The calcining plant consists of a 26-ft diameter 11-segment preheater and an 11-ft x 140-ft rotary section, discharging into a vertical contact cooler. The unit is fuelled with metallurgical grade coal brought from two sources, one in Western Canada, the other in the Eastern US. The coal is pulverized in a 493 Raymond bowl mill, dried by drawing hot air from the hood through the mill, and then blown directly into the kiln through a burner pipe which points up the axis of the kiln. The remainder of the plant is almost a duplicate of the Pavilion Lake plant described earlier.

OTHER MANITOBA PLANTS
In addition, Steel Brothers have three other plants in Manitoba:

(1) A small lime plant at Fort Whyte producing 100 tons per day of Dolomitic quicklime.

(2) A grinding plant in Fort Rouge producing feed grade calcium carbonate and mineral fillers.

(3) A silica sand plant at Selkirk producing high quality (99.6% pure) silica sand for sandblasting, foundry moulding, and glass manufacture.

PEOPLE
Key personnel at the Manitoba operations are: Frank Pearson, Division Manager; Nick Sopiwnyk, General Superintendent of Fort Whyte and Fort Rouge; Pete Roshick, General Superintendent of Selkirk Silica; Wayne Nixdorf, Plant Manager, Faulkner; Allan Jones, Sales; Bob Toal, Office Manager.

3. EXSHAW LIME PLANT
The 450-ton per day plant at Exshaw, Alberta, which was Steels first rotary kiln lime plant, is still the 'Flagship' plant of the lime operations. The plant is located 50 miles west of Calgary near the Trans-Canada Highway in the scenic Bow Corridor, which is the gateway to Banff National Park.

OPERATION
High-calcium limestone is quarried eight miles west of the plant from a high-quality vein in the Rundle formation. Drilling is done with an Airtrac drill, and loading with a front-end loader. All secondary breakage is by means of a drop ball.

Rock is hauled to the plant via tandem dump trucks averaging 14 tons per trip. These units dump onto a 42-inch by 14-foot Pioneer apron feeder which feeds the 46 x 54 Pioneer single rotor impact crusher. Minus three-inch stone from the crusher is conveyed to a 6 x 16 triple deck Ty-Rocket screen with the plus 2-in fraction being recirculated to the crusher. 2 x ¾, ¾ x ¼, and ¼-minus are stockpiled via conveyors. Each stockpile holds 6000 tons, with the two larger sizes being used as kiln feed and the ¼-minus being reduced for sale as mineral filler.

An automatic tunnel recovery system, consisting of two Jeffrey vibrating feeders and an 18-in x 375-ft belt conveyor, transfers kiln feed to a 4 x 10 single-deck Ty-Rocket screen on top of the 100-ton surge bin above the kilns. This stone dressing screen is equipped with ¼-in cloth. Feed is drawn alternately from the 2 x ¾ or the ¾ x ¼ pile, as market demands dictate. Stone is transferred to the kilns via a Schaeffer Poidometer.

The 10 x 165ft kilns are two-tier units, erected on a ⅜-inch/foot slope. Powered by 60 hp Westinghouse motors, drives are through air-cooled Eaton Dynamatic eddy current couplings, and Falk reducers. This drive allows infinite variation of kiln speed.

The kilns have 6-in linings and are equipped with 15ft of Trefoil section. The feed ends are lined with H-W Duro brick, the intermediate zones with H-W Walsh brick and the hot zones with H-W Alusite D and Magnecon. The firing hoods are lined with high-alumina plastic.

Natural gas is fired through 8-in Vulcan burners, which are each equipped with two 20hp fans, connected in series to supply high-pressure high-velocity primary air. Burning zone temperature is maintained at 2600 degrees, feed end temperature at 1500 degrees, and scrubber temperature at 160 degrees. Retention time in the kilns is three hours.

Cooling of the lime is effected by Marblehead-Niems coolers, which also measure and control the volume of secondary air that enters the kilns. Lime is discharged from the coolers at ambient temperature.

Exhaust gases are handled by Ducon UW4, size 138 scrubbers equipped with 150hp fans. The 275-gal/min water requirement of each unit is supplied from a drilled well located adjacent to the scrubber, coupled with recirculated water from a settling pond.

Capacity of each kiln is 225 tons/day of product having an ignition loss of less than 0.5 percent.

CONTROLS
Kiln instrumentation was kept simple and functional. Bailey multipen recorders chart feed end temperature, scrubber temperature, burning zone temperature, cooler discharge temperature, and fuel flow. Draught is indicated at feed end, firing hood, and cooler air lock. An orifice-type meter measures cooler air flow. Ammeters are connected to all motors associated with the kiln, and a tachometer indicates kiln speed, which is varied from 30 to 60 rev/hour, depending on the productive rate and the size of stone being calcined. The kilns are protected by flame failure devices, the heart of which is an ultraviolet scanner.

PRODUCT FLOW
Lime is elevated from the cooler to a 3-deck Dillon screen located on top of three bins, each with a capacity of 350 tons, where it is screened into three sizes: 2 x ¾, ¾ x ¼, and ¼-minus. In addition, there is a 500-ton kiln run bin. Bulk loading from these bins is by means of a belt conveyor and bucket elevator, with a capacity of 100 tons/hour. Vibrating feeders control the flow to the bulk load-out, and may be synchronized to provide a blend of sizes if required. A 5057 Raymond roller mill is used to

to the outer chimneys. Here the exhaust gas passes upward through a column of stone that is moving slowly down each chimney or segment, thereby preheating the stone and lowering the temperature of the gas. An externally-mounted 350hp induced draught fan is used to effect gas flow through the preheater.

A vibratory feeder transfers stone from the surge bin to a hydraulically actuated double-bell airlock which admits the stone to the preheater. The feeder and double bells are actuated by level sensors in the preheater. Stone which has been preheated to 1400° by the time it reaches the bottom of the chimneys is discharged by means of nine hydraulic plungers (one at the bottom of each chimney), which are actuated sequentially to push an equal amount of stone into the central chimney where it then falls directly into the feed end of the rotary kiln.

The rotary section is inclined on a slope of ⅜in per foot and rotates at speeds varying between 30 and 60 revolutions per hour, depending on the production rate. The rotation and slope of the kiln force the preheated stone to move towards the discharge or firing end of the kiln. The timing is such that the stone is completely calcined (converted to CaO) when it reaches the discharge end of the kiln where it drops into a vertical direct-contact lime cooler. Approximately 70% of the air required for combustion in the kiln is admitted through this cooler, recovering most of the sensible heat from the lime and preheating the air to 1000°F.

The kiln is fired with heavy fuel oil supplied by Union Oil Co, from their Prince George refinery. The oil is trucked to the plant where it is stored in five 10,000-gallon heated tanks until fired through a mechanically atomized Hauck burner.

When the lime is discharged from the cooler it is elevated to a 30-in x 8-ft double-deck Dillon Screen. Overs from the ¾-in top deck drop into the 500-ton silo upon which the screen is located. Throughs from the top deck pass over the ¼-in lower deck and are discharged into a 250-ton silo for shipment as ¾x¼ pebbled lime. The ¼ minus product through the bottom deck is discharged into a second 250-ton silo for shipment as crushed lime. The two 250-ton silos are elevated to allow straight line drive-through access for loading of trucks, with a truck scale located beneath them to facilitate loading of maximum legal payloads without lost time for rescaling.

The 500-ton silo is located at ground level and the coarse material from it is fed to a hammermill and then to the main elevator to be rescreened and distributed to the two finished product silos. The plant is not located on rail, and all shipments are currently being made entirely by truck because of the proximity of the existing market. However, Steel

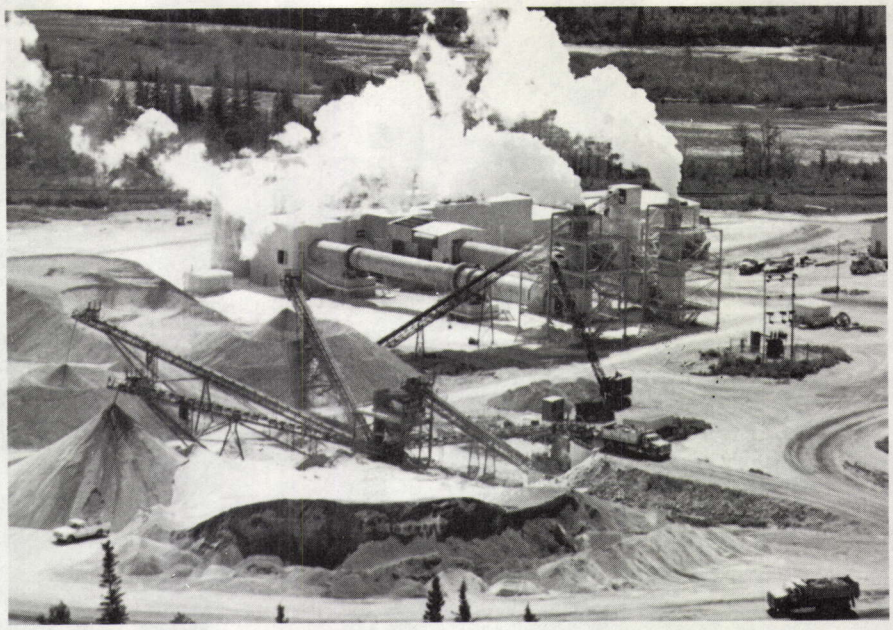
produce processed lime, which is stored in an 80-ton bin above the bagging station.

A Syntron gravimetric feeder controls the flow of ¼-minus quicklime to the 10-ton/h Knibbs hydrator, which is equipped with a variable speed, double shaft premixer. Water for hydration is introduced into a washer/preheater unit which cleans dust from the hydrator exhaust, and preheats the water, which is then fed to the premixer as a milk of lime.

Product of the hydrator is conveyed to a 14-foot Sturtevant Whirlwind separator. The minus-200 mesh portion of the product is elevated to a 50-ton bin above the packing station, to be sold as chemical grade hydrate, while the plus-200 mesh portion is processed in a tube mill and elevated to another 50-ton bin, to be packed and sold as Type 'S' Hydrate.

The system used for producing Type 'S' Hydrate is rather unique, and very simple. A highly reactive lime is reacted with very hot water, to produce a large percentage of coarse, non-expanded hydrate particles. These coarse particles are then milled to the required physical specification for Type 'S' Hydrate.

Bags are packed on sets of Jet Flow packers, supplied by Consolidated-Bathurst Packaging Ltd. Each of these two-tube units will pack 16 bags per minute. Bags are handled by conveyor directly into rail cars, or trucks, thereby eliminating the cost of warehouse handling.



Exshaw lime plant

A grinding plant at this location produces a full line of calcium carbonate products. These range from fine powders for the carpet and joint filler industries, to coarse powders for the feed and asphalt roofing industries, to gritty products for the glass industry.

PEOPLE

Key personnel are: Lime Division Manager, Don Harvey; Sales, Glynn Morrey-Jones; Plant Manager, Glen Bryant; Office Manager, Terry Weyts.

Limestone: From the St Lawrence Cement quarry near Colborne, Ontario, limestone is trucked and shipped on Lake Ontario to the cement plant near Mississauga, Ontario. Rock is blasted from a 50-ft face and loaded into 75-ton Wabco or 105-ton Euclid trucks. Loaders include the Marathon Le Tourneau L-700A, with 45,000-lb lift capacity; this unit can load the Wabcos in four cycles, Euclids in six cycles. Under optimum conditions the L-700A loads over 16,000 tons of limestone in a 16-hour day. The loader is powered by a constant-speed 800hp diesel engine with independent electric drives in each wheel.